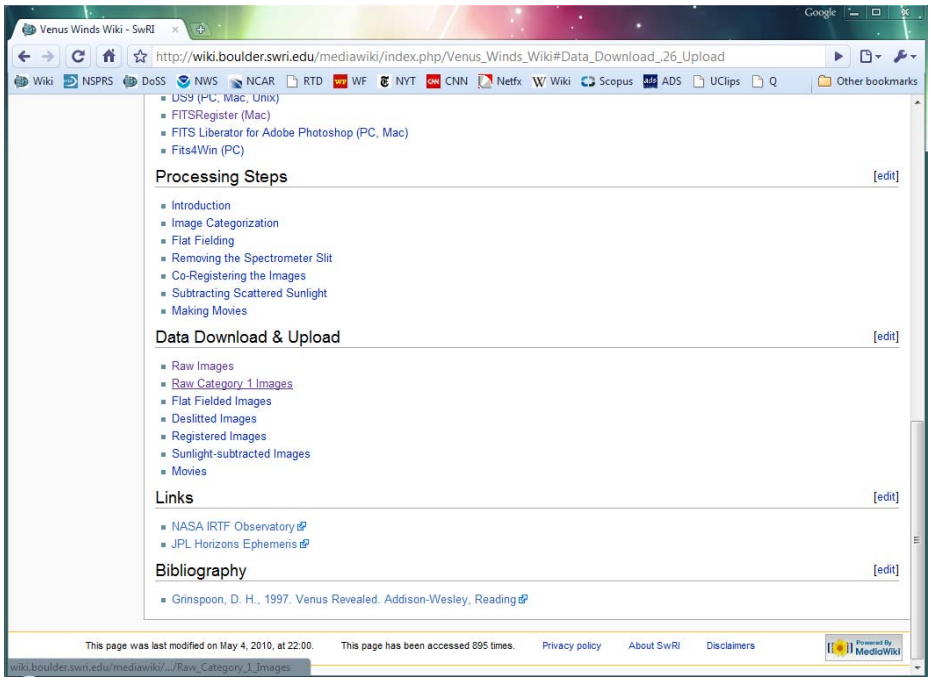
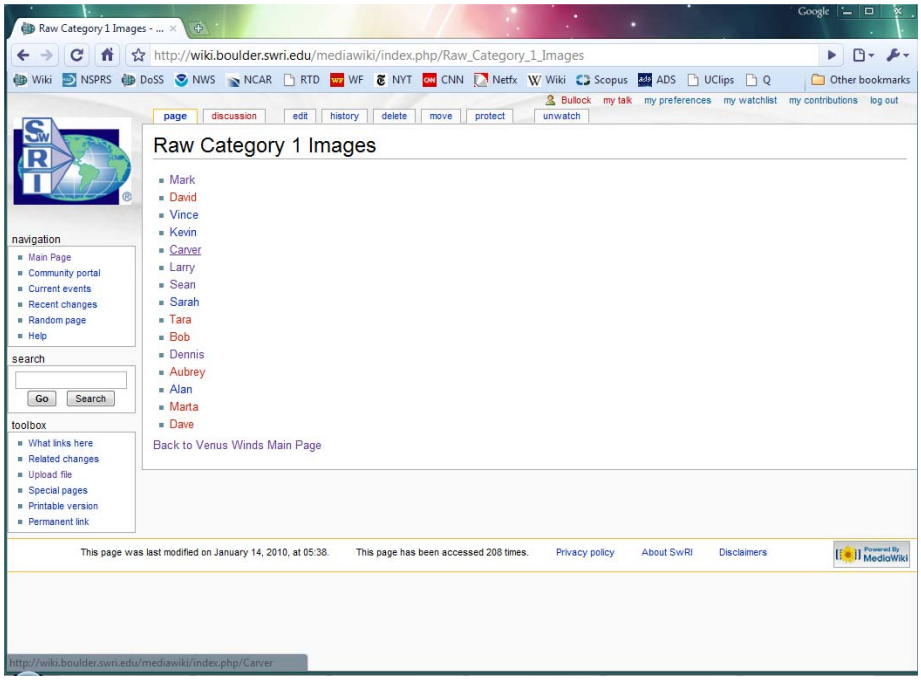
Determining Venus' Winds Mark Bullock 5/8/10

We will be using images from July 12 and July 13, 2004 to calculate the winds of Venus at several latitudes. There are features on the July 12 images that can also be seen on the July 13 images, except that they have rotated to the left as the clouds move.

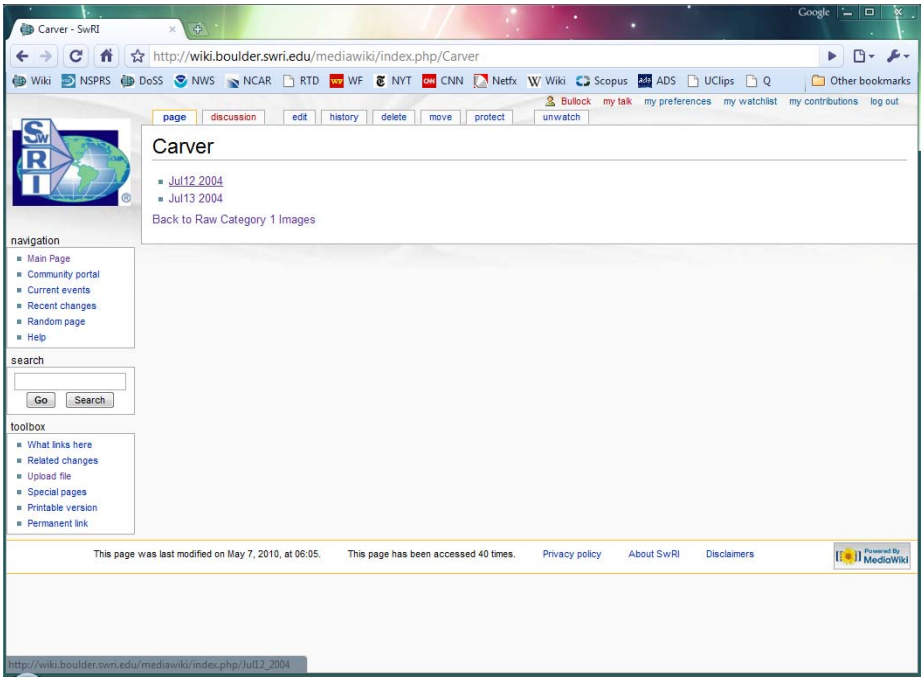
Go to the 'Data Download & Upload' part of the wiki:



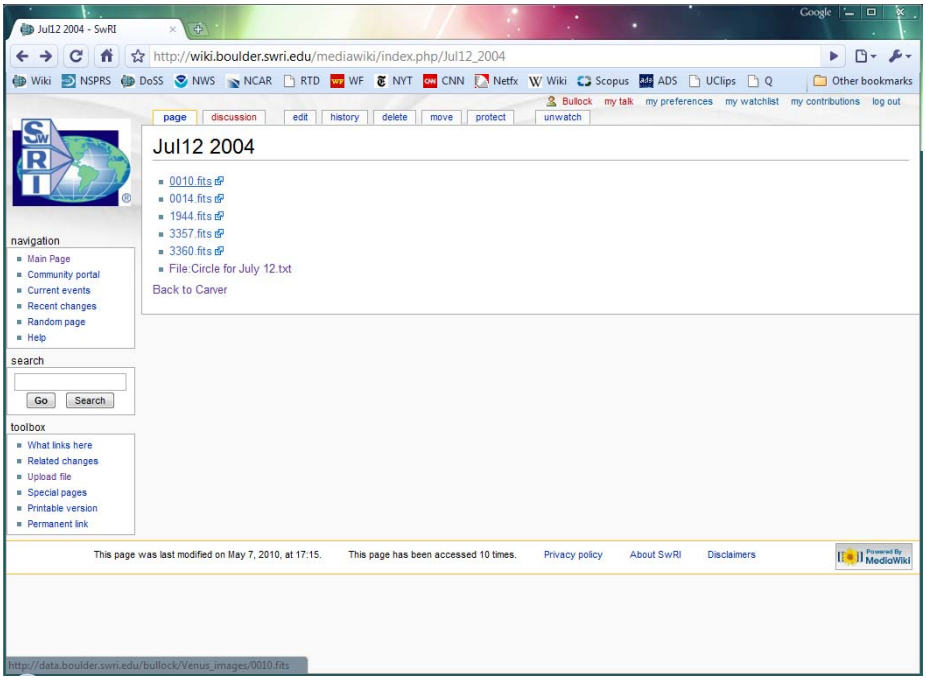
Then click on 'Carver':



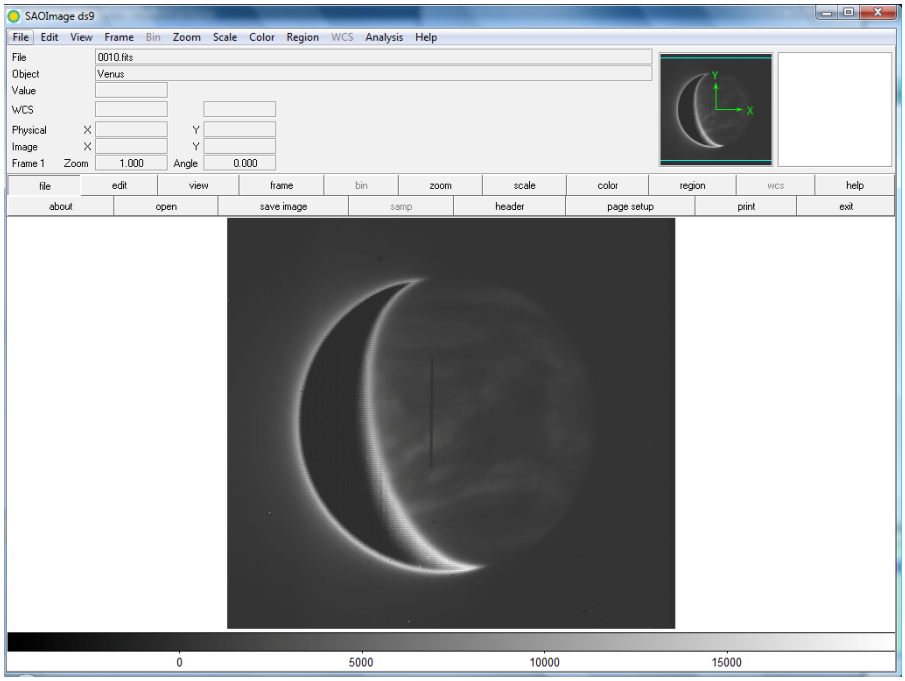
Then click on ‘Jul12 2004’:



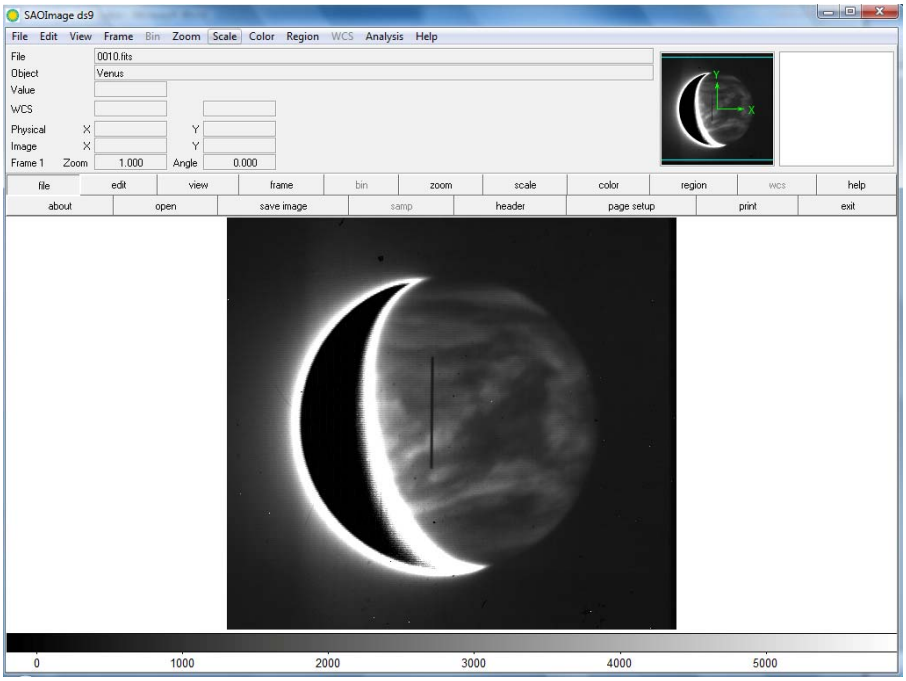
Click on an image file to download, and also download Circle for July 12.txt



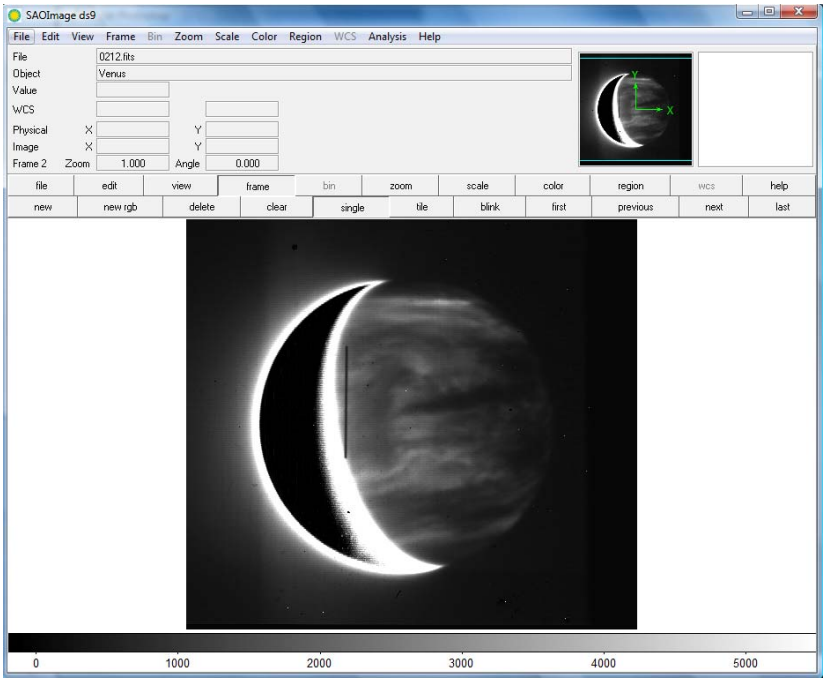
Use DS9 to open one of the image files by using the File => Open pull down menu:



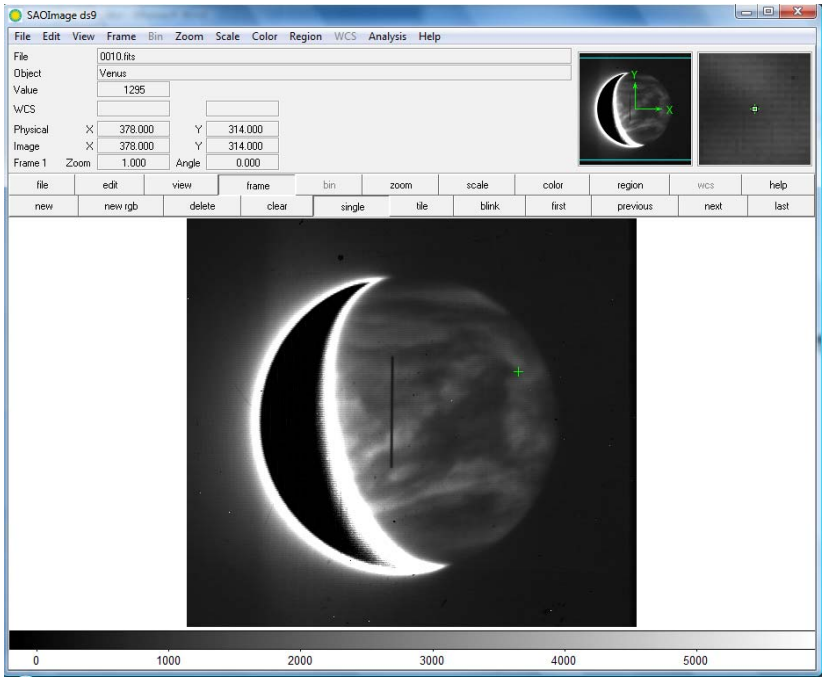
Then pull down Scale => 92.5%



Click the ‘Frame’ button, and then the ‘New’ button. Then open an image file from the next night using File => Open, and adjust its contrast using Scale => 92.5%



Now hit the ‘Blink’ button and see if you can spot any features that have gone from right to left. To stop the blinking, click the ‘Single’ button. You can also step through the images manually using the ‘Next’ and ‘Previous’ buttons. When you have identified the same feature in both images, you have to get their x,y coordinates. Go to Region => Shape => Cross Point to set your marker type. Then position your cursor on the exact spot that you would like to track. The x and y coordinates of that point are displayed in the upper left of DS9. Write those down. Then click on the point and you will see the point marked with a green + sign.



Now go to the next frame by clicking on the 'Next' button. Identify the same feature (but moved) in this image. Position the cursor on it and record the x,y point. Click on the feature to mark it with a + sign. Now when you press 'Blink', you will see where you have marked the feature and how it moves. More importantly, you've got the x,y points that we need for calculating wind velocity. For now, assume that 1 pixel is 40,000 meters (40 km). You have to get the time that each observation was made so that you can calculate the amount of time between the two images. You get this by looking at the fits image headers. Got to the pull-down menu File => Display Fits Header...

Calculating winds

Call the coordinates of the first point on your July 12 image x_1,y_1. Call the coordinates of that point on the July 13 image x_2,y_2. Then calculate the differences:

$$\Delta x = x_2 - x_1$$
$$\Delta y = y_2 - y_1$$

Let's call the scale of the image, *s*, which is approximately 40,000 meters per pixel. Then the distance the point has moved in the east-west direction, in meters, is:

$$D_{EW} = s \times \Delta x$$

The distance the point has moved in the north-south direction, in meters is:

$$D_{NS} = s \times \Delta y$$

We call the time of the first observation (which is in the image header), t_1. The time of the second observation is t_2. The total elapsed time between when the July 12 image was taken and when the July 13 image was taken is therefore:

$$\Delta t = t_2 - t_1$$

However, since the time is given in hours:minutes:seconds, you will have to convert this to seconds. Velocity is distance divided by time. So the wind velocity in the east-west direction, in meters per second is:

$$V_{EW} = \frac{D_{EW}}{\Delta t}$$

and the wind velocity in the north-south direction, in meters per second is:

$$V_{NS} = \frac{D_{NS}}{\Delta t}$$

This is all the information you need to calculate the approximate wind speeds. You can mark as many points as you want and calculated wind speeds for each pair. Bring your results on Thu May 13 to discuss! Afterwards we are going to the roof of Museum to look at Venus through telescopes. Please email me if you have any questions.